Dynamic Guide Signs System to Control Pedestrian Flow

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Abstract
As the number of people going to public facilities such as stations and airports visitors increases, the facilities become increasingly congested. To maintain personal safety and comfortableness, we have developed a dynamic guide signs system we call “Projection Sign” to control pedestrian flow. It enables signs and their information to be changed on a situational basis. This paper reports how we tested the system at Haneda Airport to examine its effectiveness. We found that users’ age and the language they use affect the signs’ visual attractiveness. We also found that the signs’ information changes user flow trends. We use these results to discuss ways to make guide signs in public spaces more effective.

Author Keywords
User Attention; Sign System; Pedestrian Control; Dynamic Guide Signs; Projection Sign

ACM Classification Keywords
H.5.2. Information interfaces and presentation (e.g., HCI): User Interfaces

Introduction
Public facilities such as stations and airports are becoming increasingly congested as more people use them. Maintaining personal safety and comfortableness requires a technique to control pedestrian flow. This is

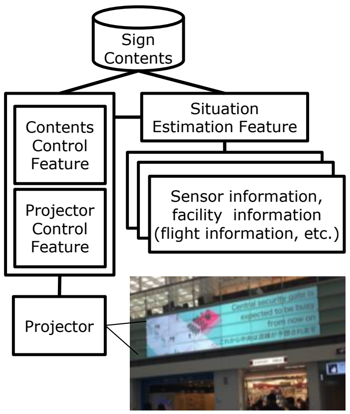

Figure 1: Projection Sign's basic system structure

particularly true for public facilities visited by a variety of persons, including persons from other countries, elderly persons, and disabled persons. The situations that occur at the facilities also widely vary. They tend to be crowded, and emergency situations may arise if a disaster occurs. There are set ways of providing guide signs in public facilities. The signs are designed to be universal, but the information and expressions they show are fixed and cannot be changed in accordance with circumstances.

To address this problem, we have developed a dynamic guide sign system we call "Projection Sign." It enables signs to be changed in accordance with circumstances such as how crowded the facility is, the age range of the people there, and the languages they speak. It should be a useful way to provide information in public facilities frequented by a variety of persons. In this paper we report the results we obtained in testing the system at Haneda Airport, and discuss ways to make guide signs in public spaces more effective.

Projection Sign

Fig. 1 shows the basic system structure. It estimates and predicts situations at facilities and determines sign contents accordingly. Users will change their direction when they see the sign, and then the system re-estimates the situation. It ascertains the situation utilizing sensors such as video cameras and BLE beacons. It also uses external information such as flight timetables at the airport.

In this paper, we show that experimentation enabled us to determine the degree to which people notice, understand, and go along with sign information, as well how much they are affected when the signs change. We carried out an experiment at Haneda Airport in the departure lobby (hereafter "DL") to determine the imbalanced crowding situation in the departure area.

Related Work

Signage systems displaying information publicly in accordance with a facility's circumstances have also been studied. The "Smart Signs" system can change guidance information by taking user and environment context into account [1]. The "GAUDI" system shows destinations and directions depending on where displays are set [2]. Display systems that sense queuing time at airports have also been developed [3]. In addition, a simulation method that assesses the impact of dynamic public signage on mass evacuation has been proposed [4].

However, no systems have been reported for use in evacuation circumstances to show how changing signs in accordance with circumstances will entice people to change their directions. There have also been no reports of how persons in evacuation circumstances are affected by a guide sign's visual attractiveness or how well they understand the information it gives.

Design

We designed the Projection Sign system on the basis of the static sign design method [5].

Guide information

One problem at Haneda Airport is that the crowding situation is unbalanced between the Central departure area (hereafter "Central area") and North departure area (hereafter "North area") in the DL. Many travelers come to the Central area because it is close to more than half of the check-in counters. Of the 40 travelers

(28 Japanese, 12 non-Japanese) we interviewed at the DL, 22 were unaware that there was another departure area. As to why they chose the Central area, 19 said because it was not crowded and 11 said because it was near the check-in counter. We therefore decided to provide two types of guide information, one showing the presence of two departure areas and their locations ("presence information"), and the other showing how congested the areas were ("congestion information").

Expression Style

For the fixed signs in the DL we decided to use three expression patterns: still, animation, and video. Figs. 2 and 3 respectively show presence information and congestion information signs. The still pattern is a pictogram with arrows to show directions and distance as used in Japanese standards [6]. Congestion information is shown as a human pictogram on a 1-5 scale. The animation pattern shows the positions of the two departure areas from a bird's-eye view of the floor map. The video pattern shows arrows and the departure area names superposed by a route video from the users' view.

Sign position

We observed the behavior of 33 travelers in the DL and from the observations decided where the sign should be so that travelers at the check-in counter could see it before going on to the security check. Using two 18000 lm projectors, we projected the sign (1.8m x 6.0m) to the wall in front of the check-in counter 4m above the ground. In the Fig.4, A and B show the places where the sign is displayed and the fan shaped parts show the areas where travelers can see the sign.

Figure 2: Presence information. Signs for uncongested situation.

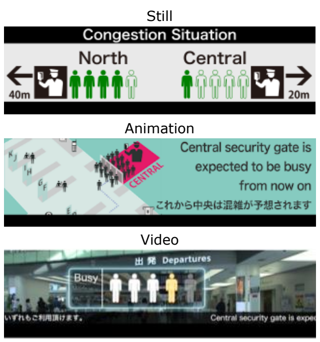

Figure 3: Congestion information. Signs for congested situation.

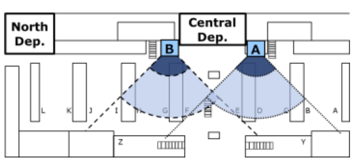

Figure 4: Departure areas and on-floor sign locations.

Projection experiment at Haneda Airport

We projected the sign, interviewed travelers, and counted the number of system users at the airport.

Outline of experiment

- Place: Haneda Airport, International Terminal
- Sign position: two points (A and B in Fig. 4)
- Sign contents: six patterns
  - Guide information: presence and congestion
  - Expression Style: still, animation, and video
  - Display time length: 30-57 seconds.
  - Languages: English and Japanese

Fig. 5 shows one sign projection point.

Outline of interviews

- Date: 9:00-17:00 on Feb. 23 and 26, 2016
- Travelers: 101 people
- Content: congestion information (more congestion in Central area)

We interviewed travelers whether they felt the sign was visually attractive ("noticeability"), whether they could understand the presence and congestion information it gave ("understanding"), and whether they felt it was useful ("useful information").

Outline of system user count

- Dates and times: 6:00-11:00 on Feb. 28, 2016 (no signs), and 6:00-11:00 on March 6, 2016 (signs)

The same time frame was chosen for both dates to match the flight schedules. Using an analog counter, we counted the number of users among the people lined up in the departure area or passing through it. On the day no signs were provided, the counting was done at 10 min. intervals. On the day when signs were provided, the counting was done at 5 min. intervals.

Figure 5: Sign projection point.

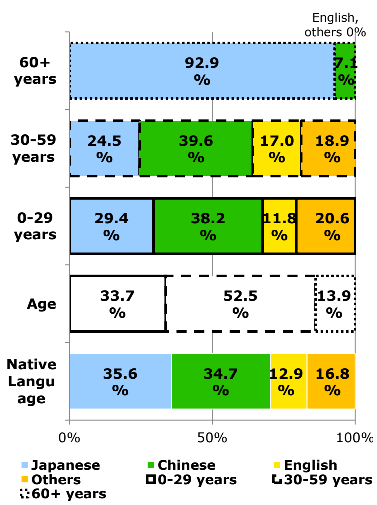

Figure 6: Distribution of basic attributes.

Discussion

Interview results and discussion

Fig. 6 shows the distribution of basic user attributes. No significant variance was found in the "Native language" category. For the "Age" category, almost all the users who were 60 years or above were Japanese. Fig. 7 shows the percentage of users who noticed or did not notice the sign for the "Native language" and "Age". Overall, 36% noticed it and 64% did not. To confirm user attribute independence for visual attractiveness we used a chi-square test, the null hypothesis for which is, "In terms of native language there is no difference in the ratio at which users noticed the sign." For this category the test results reject at the 5% level. The adjusted residuals for Japanese language are "notice": -2.6, "not notice": +2.6, so (p=0.0093) tended to notice the sign. Otherwise, for the "Age" category no significant differences were observed. We consider that the reason for this trend is that the sign was written in English and Japanese. At Haneda Airport, travelers from countries outside of Japan tend to pay attention to signs to get information, so they were more likely to notice it. In contrast, Japanese travelers can get information from sources other than signs. Fig. 8 shows the ratio at which users selected departure areas after seeing the sign. Overall, 40% selected the North area and 60% selected the Central area after seeing it. We used a chi-square test again. For the "Age" category, too, the test results reject at the 5% level. The adjusted residual of 60+ years is "central": +2.7, so (p=0.0077) tended to select the Central area. This means the sign had little or no effect on guiding users in their 60s or over to the North area. We also tested to determine whether the users' understanding of the sign influenced them in selecting the departure area. For presence and location the test results reject at the 5% level (presence: p=0.010, location: p=0.012). These results indicated that if they understood the presence or location information they would select the North area, but if they didn't they would select the Central area. Fig. 9 shows the evaluation results obtained for the "useful information" category by using the normalized-rank method. Chinese users said the congestion information was most useful at 1% level. Users 30-59 years old and those who selected the North area said it was most useful at 5% or 1% level.

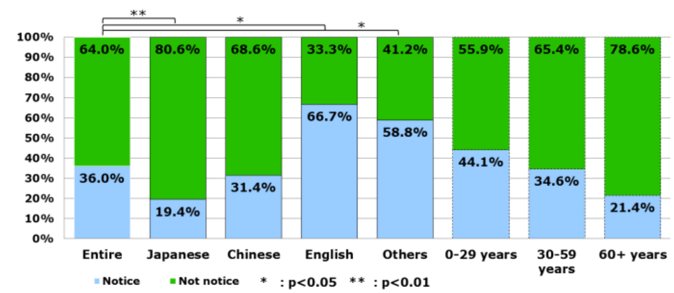

Figure 7: Percentage of users noticing/not noticing the sign.

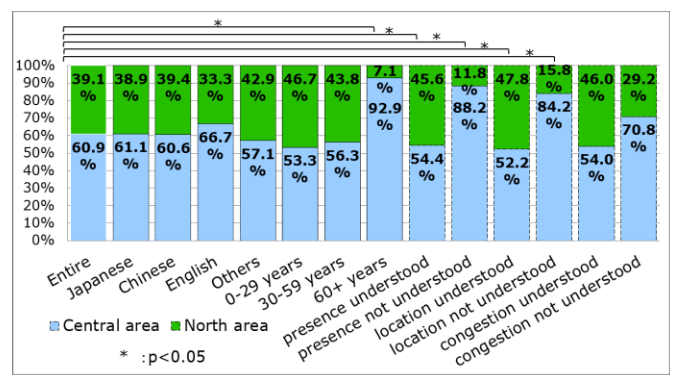

Figure 8: Ratio of departure areas selected by users after seeing the sign.

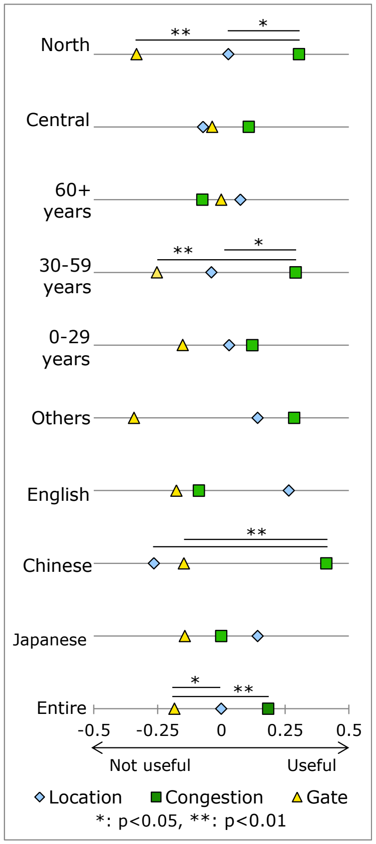

Figure 9: Evaluation results for “useful information” obtained by using normalized-rank method.

In this evaluation test, we found that the sign’s visual attractiveness largely depends on what language it is written in and whether users can get information from other media. We also ascertained that people in their 60s or over hardly ever selected the Central area whether the sign was projected or not, and that Chinese users are particularly likely to need congestion information. Consequently, we consider that if we project the sign written in a particular language, we can to some degree control users who speak that language. For example, if we project congestion information in Chinese during the check-in time for a Chinese airline, Chinese speakers will be more likely to notice the sign and change their directions after reading it.

User count results and discussion

Fig. 10 shows the number of travelers waiting in line or passing through the departure areas for both the day the sign was projected and the day it was not. On the latter day both the Central and North areas were congested, the peak congestion time period being 8:00-10:00. On the former day fewer people were waiting in line during the peak period than on the latter day. On the day the sign was not projected 4600 travelers passed through the departure areas, but 5100 passed through them on the day it was. Therefore, we believe that projecting the sign reduced the number of people waiting in line. Fig. 11 shows the shift in the ratio of the number of people waiting at the Central and North areas. The congestion information projected from 7:15 to 8:00 and from 9:15 to 9:45 (more congestion in Central area) tended to reduce the ratio of users waiting at the Central area. Fig. 12 shows the change in the number of travelers waiting as measured every 5 minutes. When congestion information was shown during congestion periods, the North area was more crowded. When presence information was shown during low-congestion periods, the Central area was more crowded. This trend matched the interview results we obtained, in which travelers who selected the North area said they wanted to go to a departure area that was less busy or nearer the check-in counter. Significant differences were found between the congestion and presence factors, but no differences were found between the day the sign was projected and the day it was not. This was due to the small numbers obtained in the analog count.

The user count results obtained indicated that providing guide information in public spaces is useful as a means to get users to change their directions. They also indicated that the type of information that is provided can change the degree of control over travelers’ movements that can be obtained.

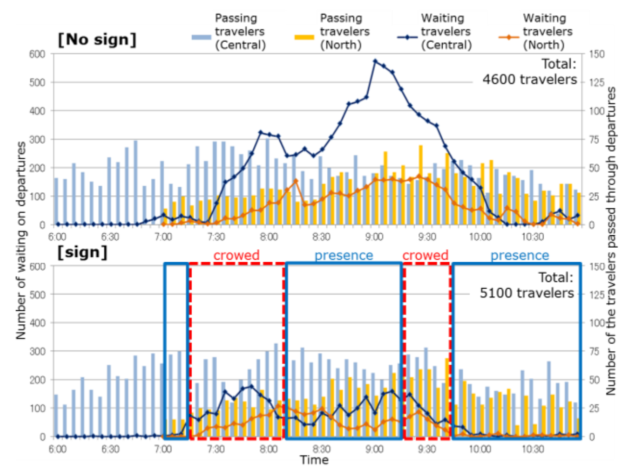

Fig. 10: Number of travelers waiting in line and passing through the departure areas.

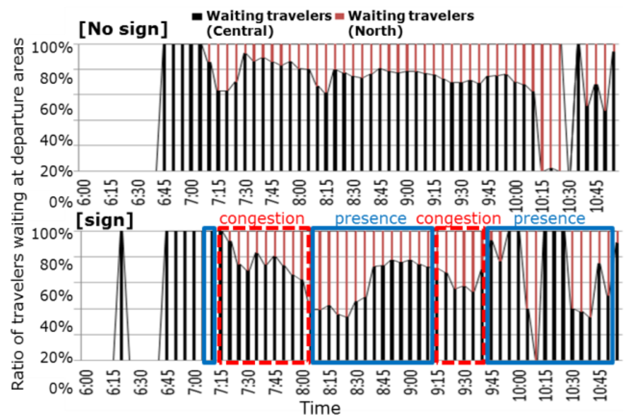

Figure 11: Ratio shift in number of travelers waiting at Central and North areas.

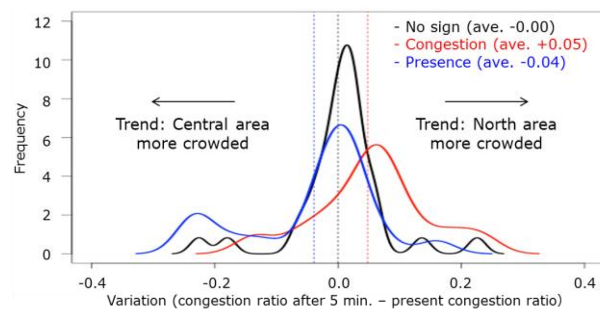

Fig. 12: Change in number of travelers waiting. (measured every 5 minutes).

Conclusion

We presented a dynamic guide signs system we have developed and call "Projection Sign" to control pedestrian flow. We conducted an experiment on the system at Haneda Airport. In interviews with travelers about the guide sign the system projected, we found that factors such as the age of users and the languages they speak affect their perception of the sign's visual attractiveness and understandability. Results obtained in counting the number of system users showed that providing guide information changed the trend in the number of travelers waiting in line in the departure areas. The experiment enabled us to find that the information the system provides can balance congestion differences at public facilities in accordance with user attributes.

Future work will be to apply state estimation techniques to the system and evaluate the system's effectiveness in providing guide information in accordance with user attributes. We will also consider ways to connect it with personal devices to alert users to signs when they display needed information.

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